(12) UK Patent Application (19) GB (11) 2 210 118 (13) A

(43) Date of A publication 01.06.1989

(21) Application No 8822142.9

(22) Date of filing 21.09.1988

(30) Priority data
(31) 098654 (32) 21.09.1987 (33) US

(51) INT CL⁴
F16D 11/06, E05B 65/20, F16H 19/04

(52) UK CL (Edition J)
F2C C1A1A2 C1A13BX C1A4 C1A5
E2A AMX A106 A135 A138 A139 A401 A515
F2Q Q3A4
U1S S1772 S1820

(56) Documents cited
None

(58) Field of search
UK CL (Edition J) F2C
INT CL⁴ F16D

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(54) Clutches and actuators for motor vehicle door locks

(57) An electric door lock actuator 12, Fig 3, for a motor vehicle includes an outer casing 46 and 48 which houses a reversible electric motor 52. The motor is coupled to a clutch assembly 63 and a gear train 76 and 80 to reciprocally move a rack 42 which extends outwardly from the casing between an advanced and a retracted position. The clutch assembly 63, Fig 4, includes a drive gear 62 coupled to the electric motor 52, and a driven gear 72 connected to operate the rack 42, through the gear train. The clutch also includes a clutch plate 66 eccentrically mounted on the clutch drive gear and having a pair of arcuately spaced driving teeth 66c and 66d alternately operably engageable with the driven clutch gear 72 when the motor is driven in either forward or reverse. When the motor is not operating, the clutch disconnects the motor shaft from the rack so that the rack can move between the advanced and retracted positions without rotating the motor shaft, a torsion spring 68 holding the clutch plate in a neutral position (Fig 5) in which the teeth are disengaged.

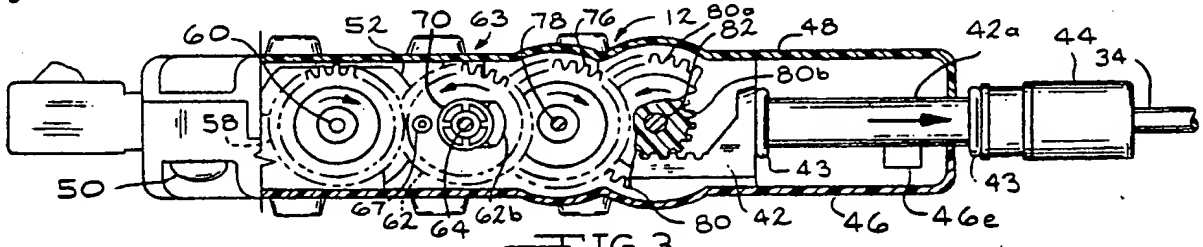

FIG. 3

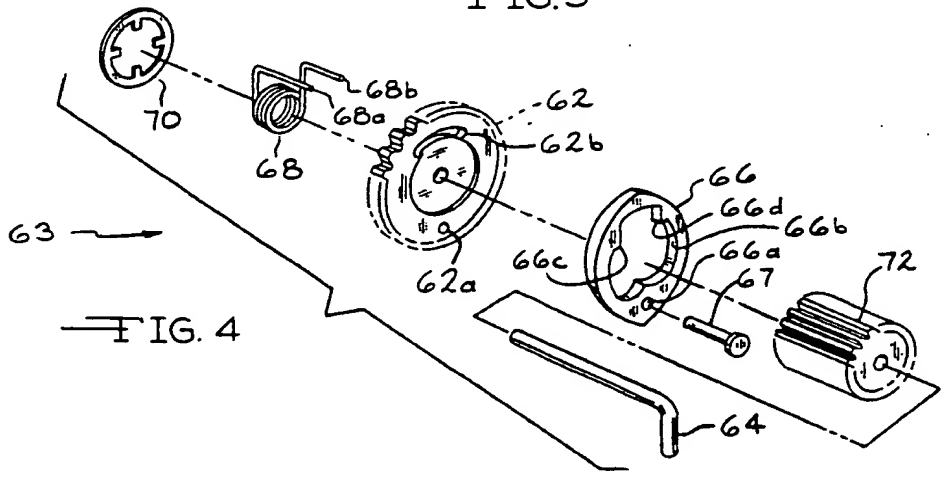

FIG. 4

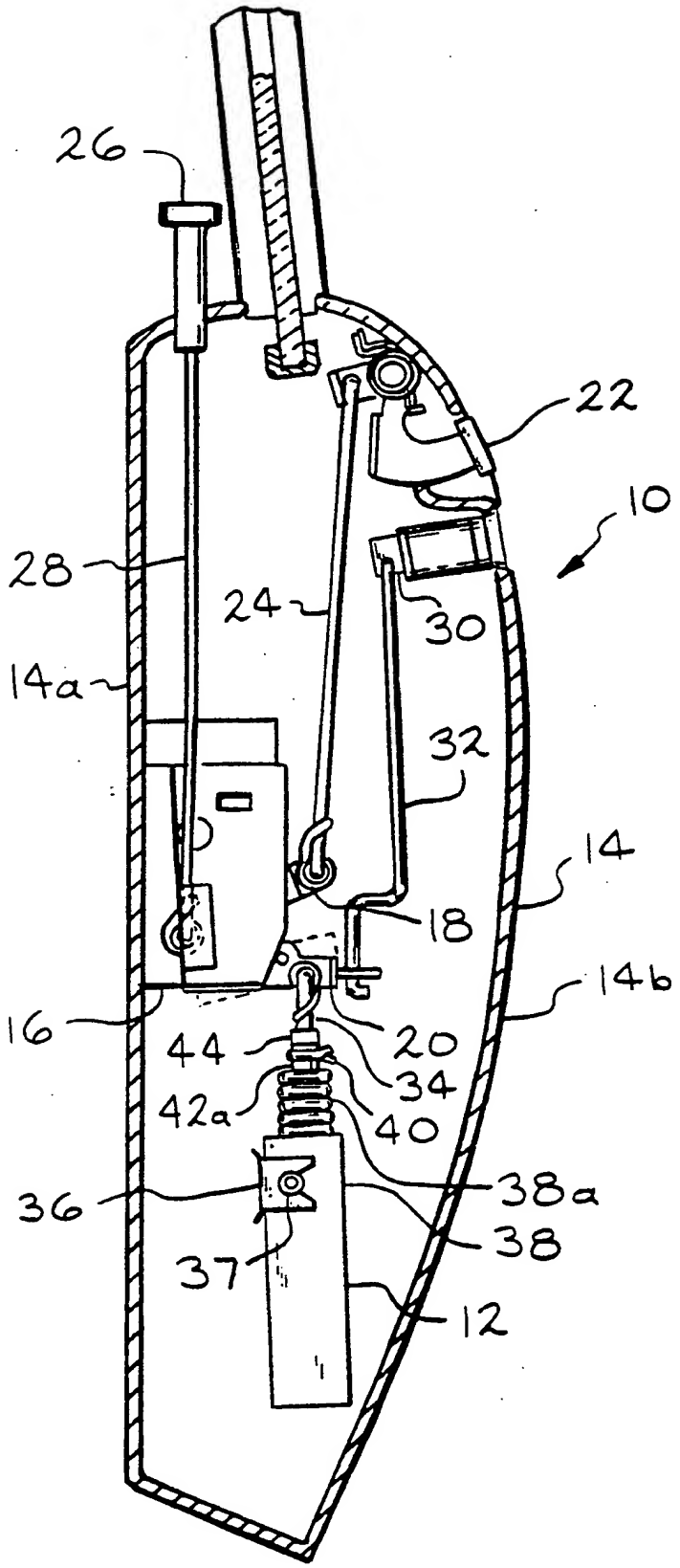

FIG. 1

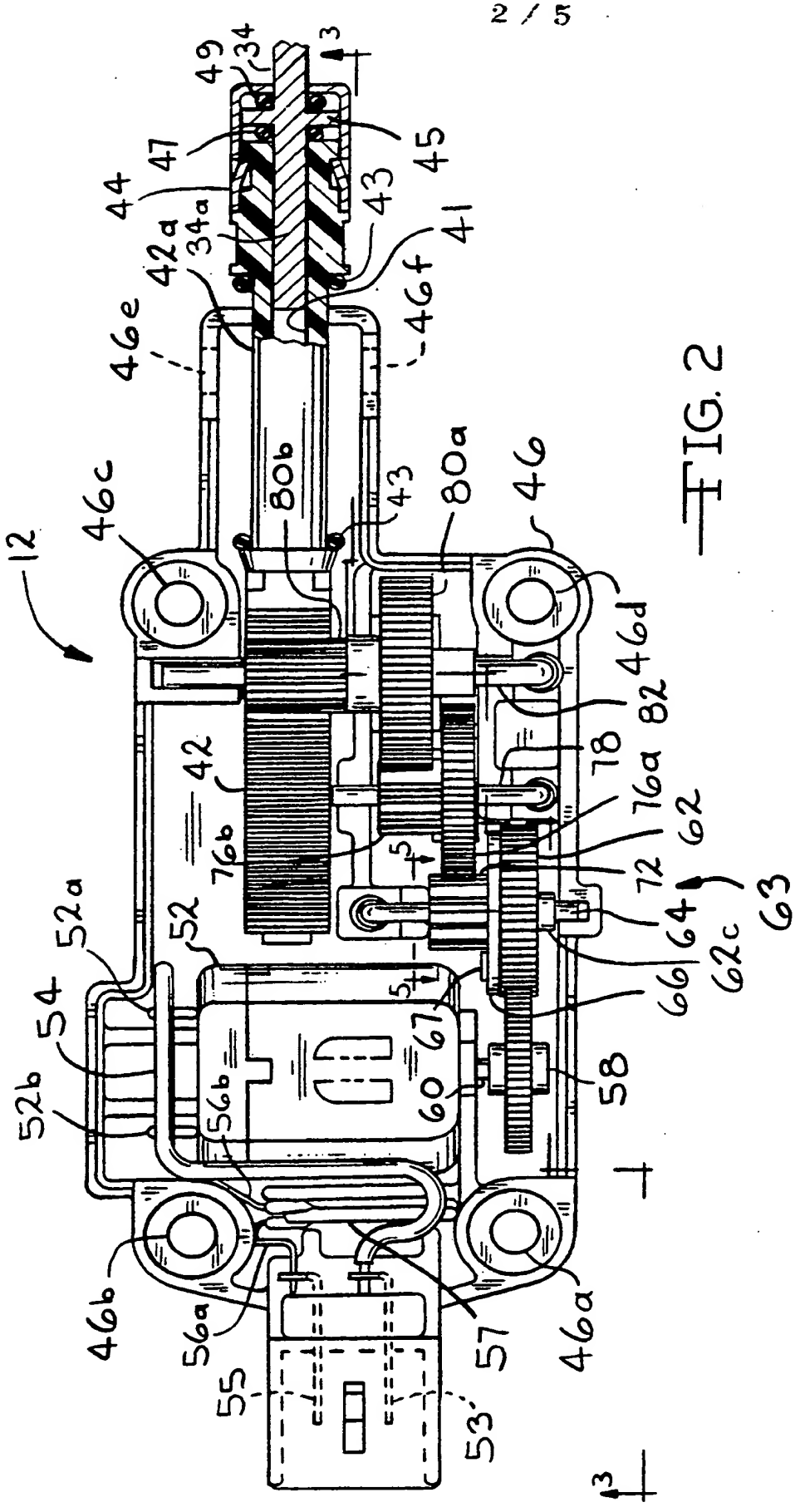
12
46c
46e
46f
46
46d
46b
46a
80b
80a
43
42
42a
34a
34
49
47
44
45
41
76b
76a
78
82
62
72
64
62c
63
66
67
60
58
52
52a
52b
54
56b
56a
55
57
53
5
5'
3
3'

FIG. 2

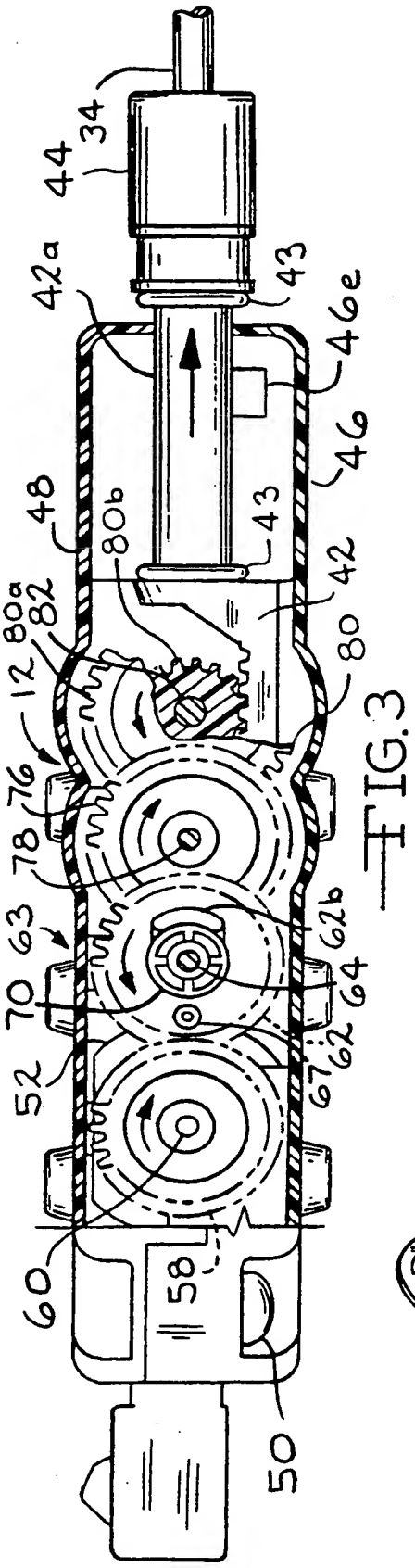
34
44
42a
43
46e
46
48
80b
43
42
80a
82
12
80
76
78
63
70
62b
64
62
67
52
60
58
50

FIG. 3

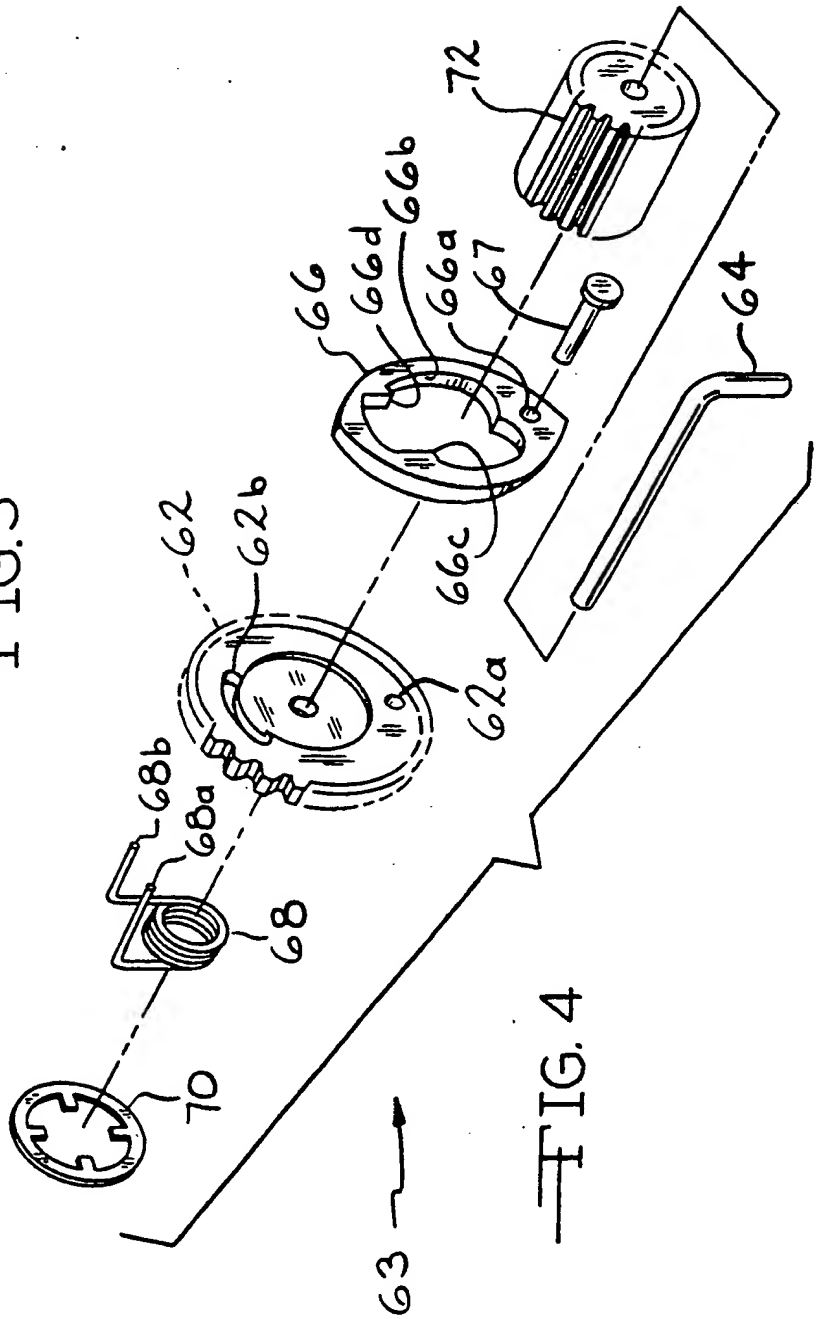
72
66b
66d
66a
67
66
64
62
62b
66c
62a
68b
68a
68
70
63

FIG. 4

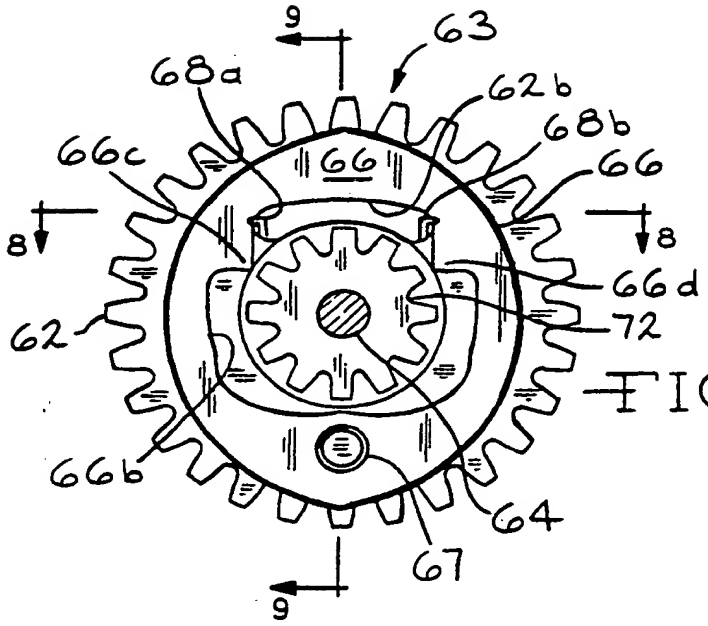

FIG. 5

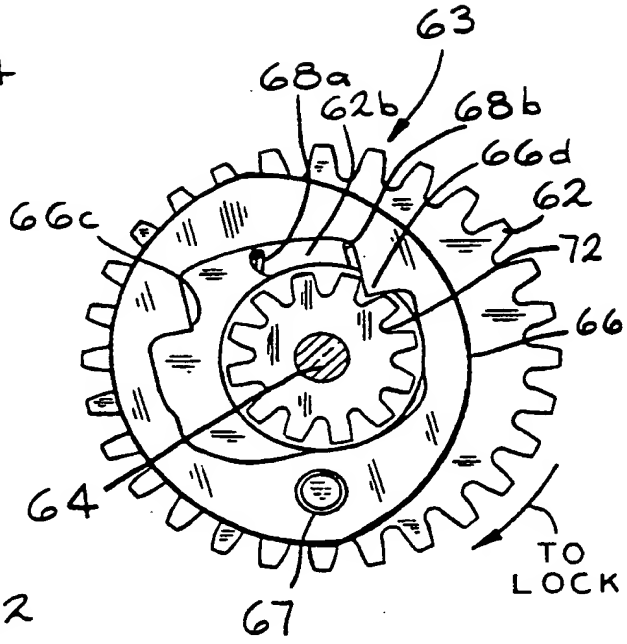

FIG. 6

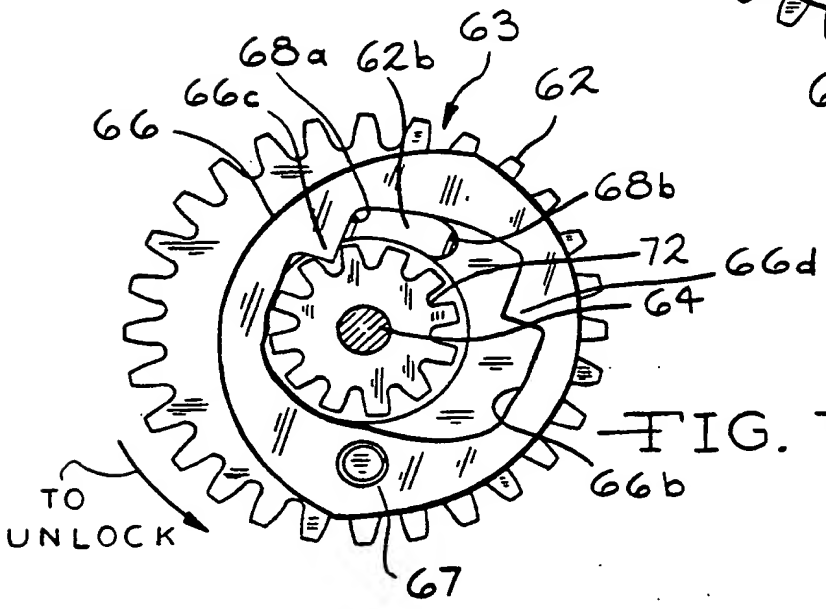

FIG. 7

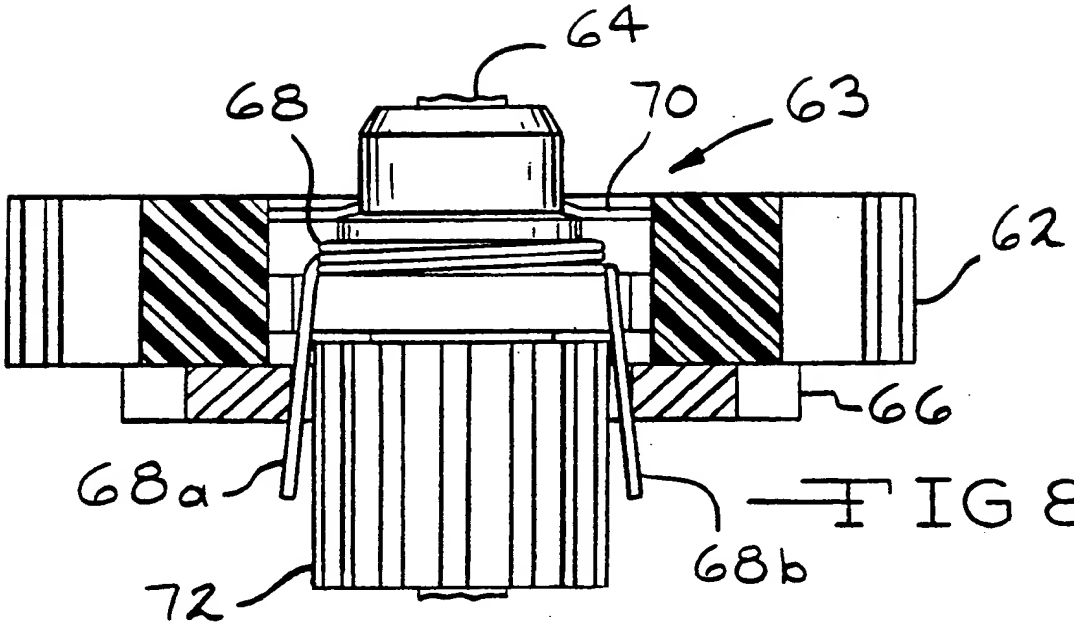

FIG 8

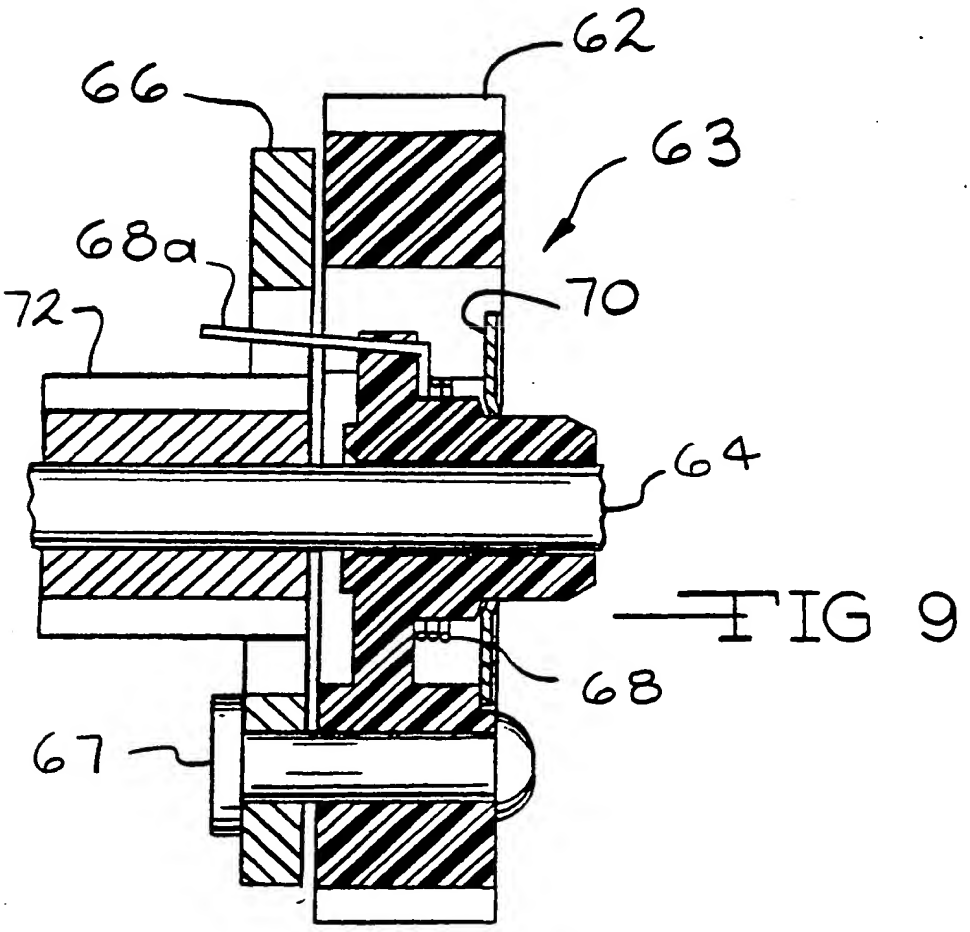

FIG 9

"Improvements in and relating to clutches and actuators"

This invention relates generally to an inertial clutch, to an electrically-operated actuator for remotely operating a mechanical mechanism, and to an actuator for operating a door lock in a motor vehicle.

An electric door-locking system typically includes a separate electric actuator which is located in each door housing and is provided with an appropriate interconnecting linkage for moving an internal door latch assembly between locked and unlocked positions. The electric actuator can be either a solenoid-operated device, or a mechanism which is driven by an electric motor.

One of the problems encountered in incorporating the actuator in the door housing relates to the limited space which is typically available. In addition to an electric door-lock actuator, vehicle doors often include power window mechanisms and/or radio loudspeakers. The problem of fitting an actuator within the door assembly becomes more difficult with smaller vehicles.

The invention provides a clutch assembly comprising: a rotatably mounted clutch drive gear having an arcuate through slot; a clutch plate eccentrically mounted on one side of the clutch drive gear for pivotal movement with respect thereto, the clutch plate having an opening defining a pair of

arcuately spaced driving teeth; a rotatably mounted driven clutch gear disposed on the said one side of the clutch drive gear and having an end portion disposed in the said opening in the clutch plate for operative engagement with either of the driving teeth, and a torsion coil spring mounted on the clutch drive gear on the other side from the clutch plate and so engaging the clutch plate through the said arcuate slot in the clutch drive gear as to bias the clutch plate into a neutral position wherein neither of the said driving teeth engages the driven clutch gear.

The invention also provides an electric actuator for operating a mechanical mechanism comprising: a reciprocably mounted rack arranged in use to be coupled to operate the mechanical mechanism; a reversible electric motor having an output shaft; and gear means operatively connecting the output shaft of the motor to the rack for reciprocating the rack, the said gear means including a inertially operated clutch for selectively driving the said rack in either an advancing or a retracting direction when the motor is operated in a forward or a reverse direction, respectively, and for disconnecting the motor shaft from the rack when the motor is not operating for permitting reciprocal movement of the rack without causing rotation of the motor output shaft.

The invention also provides an electric actuating mechanism which can be utilized as an electric door

lock actuator. The actuator has a compact design, and thus can be easily incorporated and used in automotive doors having limited space. The actuator includes an outer casing which houses a reversible electric motor. The motor is coupled to a inertial clutch assembly and a gear train to reciprocally move a rack which extends outwardly from the casing between an advanced and a retracted position. The inertially operated clutch is operative to engage the motor with the gear train either to advance or to retract the rack when the motor shaft is operated in either a forward or a reverse direction. When the motor is not operating, the clutch disconnects the motor shaft from the gear train and permits the rack to be moved between the advanced and retracted positions without rotating the motor shaft.

The inertially operated clutch which is incorporated into the door lock actuating mechanism includes a drive gear coupled to the electric motor, and a driven gear connected to operate the rack through the gear train. The clutch also includes an inertially operated clutch plate eccentrically mounted on the clutch drive gear and having a pair of arcuately spaced driving teeth either of which may engage with the driven clutch gear, depending on whether the motor is driven in a forward or a reverse direction.

One form of door-lock actuator constructed in accordance with the invention will now be described by way of example only with reference to the accompanying

drawings, in which:

Fig. 1 is a vertical sectional view of an automobile door incorporating a door lock actuator;

Fig. 2 is a plan view of the door lock actuator seen in Fig. 1, with a protective cover removed;

Fig. 3 is a side elevation view of the door lock actuator shown in Fig. 2, in partial section taken generally along the line 3-3 of Fig. 2 including the protective cover;

Fig. 4 is an exploded perspective view of a clutch assembly forming part of the door lock actuator shown in Figs. 1 to 3;

Fig. 5 is an elevation view of the clutch assembly shown in Figs. 2 to 4, in partial section taken generally along the line 5-5 of Fig. 2, and showing the clutch-disengaged or neutral condition;

Fig. 6 is a view similar to Fig. 5, showing the clutch assembly engaged for moving a door lock towards a locked position;

Fig. 7 is a view similar to Figs. 5 and 6, showing the clutch assembly engaged for moving a door lock towards an unlocked position;

Fig. 8 is a sectional view of the clutch assembly taken generally along the line 8-8 of Fig. 5; and

Fig. 9 is a sectional view of the clutch assembly taken generally along the line 9-9 of Fig. 5.

Referring to the drawings, and initially to Fig. 1, a vehicle door indicated generally by the reference

number 10 has a door lock actuator 12 constructed in accordance with the present invention mounted therein. While the compact structure of the actuator 12 is particularly suitable for use in relatively thin doors of smaller cars, it can also perform adequately in doors of larger cars, or can be used for remotely operating mechanical mechanisms other than automobile door locks. Except for the actuator 12, all other components shown in Fig. 1 may be conventional, as may the door latch, which is not shown but, typically, consists of a V-notched plate pivotable into and out of latching relationship with a stationary pin on the car frame.

As shown in Fig. 1, the door 10 includes a hollow metal enclosure 14 including an inboard panel 14a and an outboard panel 14b. A frame 16 for the latching and locking mechanism is typically mounted on the inner side of the inboard panel 14a (that is to say, the side towards the interior of the enclosure 14) and accommodates a pivotally mounted latching lever 18 and a pivotally mounted locking lever 20. The locking lever 20 is shown in solid lines in the "unlocked" position and in broken lines in the "locked" position. An outside handle 22, accessible from outboard of the door 10, is pivotally mounted on the inner side of the outboard panel 14b and is operatively connected to the latching lever 18 by a rod 24. When the locking lever 20 is in the unlocked position, the handle 22 can be

operated to open the door 10. Also, an inside handle (not shown) is operatively connected to the latching lever 18. Conversely, when the locking lever 20 is in the locked position, it interferes with movement of the latching lever 18 and neither the inside handle nor the outside handle 22 can be operated to open the door 10.

The locking lever 20 is typically movable between the locked and unlocked positions by any of one of three actuating means: an inside push-pull button 26 operatively connected to the locking lever by a rod 28; an outside key-operated lock cylinder 30 operatively connected to the locking lever by a rod 32; and a rod 34 operatively connected to and forming a part of the actuator 12.

A bracket 36 provided with grommets 37 is suitably mounted in the enclosure 14 and pivotally supports the actuator 12, which is typically protected against infiltration of water from above by a rubber skirt 38. The skirt 38 is clamped by a clamp 40 to a cylindrical extension 42a (see Figs. 2 and 3) of a rack 42 of the actuator 12. An upper portion 38a of the skirt 38 is pleated to accommodate the stroke of the rack 42. One end 34a of the actuator rod 34 is received in an elongate recess 41 in the rack extension 42a and is secured to the rack extension by a retaining cap 44 and O-rings 47 and 49, as best shown in Fig. 2.

As may be seen in Figs. 2 and 3, the actuator 12 has a casing including a base 46 and a cover 48

typically held together by any suitable fasteners 50. The fasteners 50 project through respective holes 46a, 46b, 46c, and 46d (Fig. 2) in the base 46. The cover 48 also has a snap-in connection to the base 46, provided by a pair of prongs (not shown) having tapered lugs which snap respectively into a pair of rectangular holes 46e and 46f provided respectively in side walls of the base 46.

An electrically reversible motor 52 is mounted in the base 46, as shown in Fig. 2. One terminal 52a of the motor is electrically connected to a plug-in terminal 53 by a wire 54. A second terminal 52b of the motor is electrically connected to a plug-in terminal 55 by a pair of electrical conductors 56a and 56b having a circuit interrupter 57 connected therebetween. When energized, the motor 52 rotates a drive gear 58 fixedly mounted on an output shaft 60 of the motor. The drive gear 58 operatively engages a clutch drive gear 62, forming a part of a clutch assembly indicated generally by the reference numeral 63 rotatably mounted on a shaft 64 fixed to the base 46.

Referring also to Figs. 4, 5, 8 and 9, the clutch assembly 63 includes an eccentrically mounted clutch plate 66 pivotally mounted upon a clutch pin 67 that extends through an aperture 66a in the clutch plate 66 and is fixedly s cured in an aperture 62a of the clutch drive gear 62. The clutch pin 67 is parallel to the portion of the shaft 64 that forms the axle for the

clutch drive gear 62. The clutch drive gear 62 includes an arcuate slot 62b for receiving therein the circumferentlally spaced, axially extending straight end portions 68a and 68b of a torsion coil spring 68. The spring 68 is retained in position on a hub 62c on the side of the clutch drive gear 62 away from the clutch plate 66 by a push-on fastener 70. The end portions 68a and 68b of the torsion coil spring 68 extend parallel to the axial portion of the shaft 64 through the slot 62b in the clutch drive gear 62 and into an opening 66b in the clutch plate 66.

A driven clutch gear 72 is rotatably mounted on the axle portion of the shaft 64 adjacent to the clutch drive gear 62 and on the same side thereof as the clutch plate 66. The gear 72 extends through the opening 66b in the clutch plate 66. The opening 66b includes a pair of spaced driving teeth 66c and 66d either of which may engage the driven clutch gear 72, as explained hereinafter.

Referring now to Figs. 5 to 7, the clutch assembly 63 is shown in Fig. 5 in a neutral or clutch-disengaged position which occurs whenever the motor 52 is de-energized. In this position, the torsion spring ends 68a and 68b centre the clutch plate 66 with respect to the clutch drive gear 62 so that neither of the driving teeth 66c and 66d engages the driven clutch gear 72.

Fig. 6 shows the clutch assembly 63 in a "lock apply" mode which occurs when the motor 52 and the

motor driv gear 58 accelerate clockwise as seen in Fig. 3 thereby causing the clutch assembly 63 to accelerate anticlockwise as seen in Fig. 3 and clockwise as seen in Fig. 6. As seen in Fig. 6, the clutch plate 66, because of its own intertia and because it can pivot about the clutch pin 67 relative to the clutch drive gear 62, undergoes less clockwise acceleration than does the clutch drive gear 62 so that the clutch plate 66 rotates counterclockwise relative to the clutch drive gear 62 about the clutch pin 67. The inertia of the clutch plate 66 is sufficient to overcome the force of the torsion coil spring 68, and the clutch plate thus continues to rotate counterclockwise relative to the clutch drive gear 62 until the driving tooth 66d engages the driven clutch gear 72 and thereby imparts clockwise rotation to the driven clutch gear 72. Fig. 6 illustrates a highly preferred configuration of the clutch assembly 63 in that the reaction force or resistance to rotation of the driven clutch gear 72 exerts a counterclockwise torque, as seen in Fig. 6, on the clutch plate 66 when the actuator 12 is in the locking mode. This counterclockwise torque aids in maintaining the driving tooth 66d in positive engagement with the driven clutch gear 72 to ensure that th driving tooth 66d does not ratchet over the crowns of the teeth of the driven clutch gear 72, and thus to nsure proper operation of the clutch assembly 63 and to prolong the life of the

clutch assembly 63 by reducing wear on the driving tooth 66d and on the driven clutch gear 72.

Upon stoppage of the driven clutch gear 72, as when the lever 20 reaches its locked position, the motor 52 also stops because of the engagement of the driving tooth 66d with the clutch gear 72, whereupon electrical power to motor 52 is cut off either by the vehicle user's turning a key in a lock cylinder corresponding to the lock cylinder 30 or by the circuit interrupter 57 which operates automatically after the door lock actuator 12 reaches the locked position. Thereafter, the torsion coil spring 68 effects disengagement of the clutch plate 66 from the driven clutch gear 72 and rotation of the clutch plate 66 to the neutral position shown in Fig. 5.

As shown in Figs. 2 and 3, the driven clutch gear 72 is in mesh with one gear 76a of a double gear 76 rotatably mounted on a shaft 78 secured in the base 46. The other gear 76b of the double gear 76 is in mesh with one gear 80a of a double gear 80 rotatably mounted on a shaft 82 secured in the base 46. The other gear 80b of the double gear 80 operatively engages the rack 42. Thus, clockwise rotation of the motor shaft 60 and the motor drive gear 58 (as seen in Fig. 3) causes translation of the rack 42 and the attached actuator rod 34 to the right, thereby locking the door lock mechanism. Similarly, counterclockwise rotation of the motor shaft 60 and the motor drive gear 58 (as seen in

Fig. 3) effects unlocking of the door lock mechanism.

Fig. 7 shows the clutch assembly 63 in a clutch-engaged condition which occurs when the motor shaft 60 and the motor drive gear 58 are rotated to unlock the door lock mechanism. That configuration of the clutch assembly 63 results from the counterclockwise angular acceleration of the clutch assembly 63, as seen in Figs. 5 to 7, wherein the clutch plate 66, because of its own inertia, undergoes less counterclockwise acceleration than does the clutch drive gear 62 so that the clutch plate 66 rotates clockwise, relative to the clutch drive gear 62, about the clutch pin 67. The inertia of the clutch plate 66 overcomes the force of the torsion coil spring 68 and thus the clutch plate continues to rotate clockwise relative to the clutch drive gear 62 until the driving tooth 66c engages the driven clutch gear 72 and thereby imparts counter-clockwise rotation to the driven clutch gear. The reaction force of the driven clutch gear 72 creates a clockwise torque on the clutch plate 62 which aids in maintaining constant engagement of the clutch plate 62 with the driven clutch gear 72.

The cylindrical extension 42a of the rack 42 is preferably provided with a pair of elastomeric O-rings 43 that are compressed against end walls of the base 46 and of the cover 48 to absorb the shock should the end of the retraction and extension stroke of the rack 42 ever be reached. However, it is expected that in most

applications the lever 20 shown in Fig. 1 will reach its locked and unlocked end positions before the rack 42 reaches the end of its extension and retraction strokes, respectively. To protect the rack 42 and the gear train, additional shock absorbing O-rings 47 and 49 are provided on the rod 34, either side of a collar 45 by means of which the rod 34 is held between the end of the rack extension 42a and the retaining cap 44. Thus, any impact shock transferred to the rod 34 by the lever 20 during the extension or retraction stroke of the rack 42 is absorbed by the O-ring 49 or 47, respectively.

By the present invention a compact door lock actuator can be provided which readily fits within the thin door of a small, compact car. The actuator can also be relatively light in weight, because it can be made largely of plastics parts. The motor 52 is a relatively high-speed, low-torque motor and thus requires the mechanical advantage afforded by the larger gears or gear portions 62, 76a, and 80a driving smaller gears or gear portions 72, 76b, and 80b, respectively, without relative rotation. When it is desired to lock or unlock a door 10 manually, however, as by a key inserted in the lock cylinder 30 or by operation of the push-pull button 26, the mechanical advantage afforded to the motor 52 by the gear train becomes a mechanical disadvantage, since the larger gears or gear portions are then driven manually by

operation of the smaller gears or gear portions. The clutch assembly 63 thus enables manual locking or unlocking of the automobile door 10 without rotation of the motor 52, its shaft 60, the drive gear 58, and the clutch drive gear 62 with its clutch plate 66 and torsion coil spring 68. Therefore, in the actuator 12, manual operation starts with movement of the rack 42 and terminates in free rotation of the driven clutch gear 72.

What we claim is:

1. A clutch assembly comprising: a rotatably mounted clutch drive gear having an arcuate through slot; a clutch plate eccentrically mounted on one side of the clutch drive gear for pivotal movement with respect thereto, the clutch plate having an opening defining a pair of arcuately spaced driving teeth; a rotatably mounted driven clutch gear disposed on the said one side of the clutch drive gear and having an end portion disposed in the said opening in the clutch plate for operative engagement with either of the driving teeth, and a torsion coil spring mounted on the clutch drive gear on the other side from the clutch plate and so engaging the clutch plate through the said arcuate slot in the clutch drive gear as to bias the clutch plate into a neutral position wherein neither of the said driving teeth engages the driven clutch gear.

2. A clutch assembly as claimed in claim 1, wherein the torsion coil spring is mounted on a hub portion of the clutch drive gear and held thereon by a push-on fastener.

3. A clutch assembly as claimed in claim 1 or claim 2, wherein the clutch drive gear and the driven clutch gear are mounted on a common shaft and the clutch plate is mounted on a pin disposed on the clutch drive gear eccentrically of the shaft.

4. A clutch assembly as claimed in claim 3, wherein the said pin is mounted in a pin-mounting hole

in the clutch drive gear.

5. A clutch assembly substantially as herein-before described with reference to, and as shown in, Figs. 4 to 9 of the accompanying drawings.

6. An electric actuator comprising a clutch assembly as claimed in any one of claims 1 to 5, a reversible electric motor operatively connected to the clutch drive gear of the clutch assembly, and a rack operatively connected to the driven clutch gear and arranged in use to be coupled to a mechanism that is to be actuated.

7. An electric actuator for operating a mechanical mechanism comprising: a reciprocably mounted rack arranged in use to be coupled to operate the mechanical mechanism; a reversible electric motor having an output shaft; and gear means operatively connecting the output shaft of the motor to the rack for reciprocating the rack, the said gear means including a inertially operated clutch for selectively driving the said rack in either an advancing or a retracting direction when the motor is operated in a forward or a reverse direction, respectively, and for disconnecting the motor shaft from the rack when the motor is not operating for permitting reciprocal movement of the rack without causing rotation of the motor output shaft.

8. An actuator as claimed in claim 7 wherein the inertially operated clutch is a clutch assembly as

claimed in any one of claims 1 to 5.

9. An actuator as claimed in claim 6 or claim 8, which includes a second shaft, a first double gear rotatably mounted on the said second shaft and including a larger gear portion operatively engaged with the driven clutch gear and a smaller gear portion; a third shaft; a second double gear rotatably mounted on the said third shaft and including a larger gear portion operatively engaged with the smaller gear portion of the first double gear, and a smaller gear portion operatively engaged with the rack.

10. An actuator as claimed in claim 9, wherein each of the said shafts is generally L-shaped and which has a casing including a base and a cover, a short leg portion of each of the said L-shaped shafts being anchored in the base and a free end portion of a long leg portion of each of the said L-shaped shafts being clamped to or held in the base by the cover.

11. An actuator as claimed in any one of claims 6 to 10, wherein one end of a casing of the actuator is provided with a pair of plug-in terminals electrically connected to the motor.

12. An actuator as claimed in any one of claims 1 to 11, including a circuit interrupter for interrupting an electric power supply to the motor after the rack reaches an end of its travel.

13. An electric actuator substantially as herein-before described with reference to, and as shown in,

the accompanying drawings.

14. A door-lock actuator for a motor vehicle which is an actuator as claimed in any one of claims 6 to 13.

15. A motor vehicle having at least one door with a lock, an actuator as claimed in claim 14 arranged to operate that lock, and at least one other means of operating the lock.

16. A motor vehicle as claimed in claim 15, wherein the said actuator is arranged to operate the said lock when a lock on another door is actuated by another means.

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